

Complete Summary

GUIDELINE TITLE

Vomiting in infants up to 3 months of age.

BIBLIOGRAPHIC SOURCE(S)

Cohen HL, Strain JD, Fordham L, Gelfand MJ, Gunderman R, McAlister WH, Slovis TL, Smith WL, Expert Panel on Pediatric Imaging. Vomiting in infants up to 3 months of age. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 7 p. [39 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Cohen HL, Babcock DS, Kushner DC, Gelfand MJ, Hernandez RJ, McAlister WH, Parker BR, Royal SA, Slovis TL, Smith WL, Strife JL, Strain JD, Kanda MB, Myer E, Decter RM, Moreland MS. Vomiting in infants up to 3 months of age. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):779-86.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

COMPLETE SUMMARY CONTENT

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SCOPE

DISEASE/CONDITION(S)

Vomiting in newborns and infants

GUIDELINE CATEGORY

Diagnosis
Evaluation

CLINICAL SPECIALTY

Emergency Medicine
Family Practice
Pediatrics
Radiology

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To evaluate the appropriateness of initial radiologic examinations for infants with vomiting

TARGET POPULATION

Newborns and infants up to 3 months of age with vomiting

INTERVENTIONS AND PRACTICES CONSIDERED

1. X-ray
 - Upper gastrointestinal (UGI) series, positive contrast with fluoroscopy
 - Abdomen
2. Ultrasound (US), abdomen (UGI tract)
3. Nuclear medicine (NUC), stomach/motility/gastroesophageal reflux (GER)

Note: Diagnostic studies that are complementary to imaging examinations include esophageal pH monitoring, esophageal motility studies, and endoscopic evaluation of the esophagus

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

The total number of source documents identified as the result of the literature search is not known.

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed for reaching agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table and narrative as developed by the topic leader(s). Questionnaires are completed by participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1 to 9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a

consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by the Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

One study, in reviewing the cost, risk and benefit of first using ultrasound (US) in the analysis of the vomiting child in two pediatric hospitals, found a 33% reduction in the number of upper gastrointestinal (UGI) series performed, but a 95% increase in overall cost because the remaining patients went on to a UGI series. Another study found an increased cost among their patients because only 44% had hypertrophic pyloric stenosis (HPS) and the others went on to UGI series.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Vomiting in Infants Up to 3 Months of Age

Variant 1: Bilious vomiting.

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, UGI series, positive contrast with fluoroscopy	9	
X-ray, abdomen	5	

Radiologic Exam Procedure	Appropriateness Rating	Comments
US, abdomen (UGI tract)	2	
NUC, stomach/motility/GER	1	
Appropriateness Criteria Scale 1 2 3 4 5 6 7 8 9 1 = Least appropriate 9 = Most appropriate		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Intermittent vomiting since birth.

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, UGI series, positive contrast with fluoroscopy	6	
US, abdomen (UGI tract)	4	
X-ray, abdomen	2	
NUC, stomach/motility/GER	1	
Appropriateness Criteria Scale 1 2 3 4 5 6 7 8 9 1 = Least appropriate 9 = Most appropriate		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Projectile nonbilious vomiting.

Radiologic Exam Procedure	Appropriateness Rating	Comments
US, abdomen (UGI tract)	8	
X-ray, UGI series, positive contrast with fluoroscopy	5	

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, abdomen	2	
NUC, stomach/motility/GER	1	
<p>Appropriateness Criteria Scale</p> <p>1 2 3 4 5 6 7 8 9</p> <p>1 = Least appropriate 9 = Most appropriate</p>		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Vomiting, or the forceful extrusion of gastric contents, is never normal in the neonate and usually occurs because of complete or partial obstruction somewhere along the course of the gastrointestinal (GI) tract between the stomach and cecum. However, there may be difficulty in differentiating clinically between vomiting and regurgitation.

Regurgitation, or GER, is a common finding in the first 3 months of life. It usually has no definitive pathologic cause, is unrelated to a functional defect, and resolves with time. In some cases, regurgitation may be due to displacement of a portion of the stomach into the chest (i.e., hiatal hernia). In other cases, low esophageal sphincter pressures or delays in gastric emptying have been implicated as causative.

The role of imaging in evaluating the vomiting infant is to define whether and where there is a point of anatomic obstruction. Secondarily, one should note whether there is GER or delayed gastric emptying. Diagnostic studies that are complementary to imaging examinations include esophageal pH monitoring, esophageal motility studies, and endoscopic evaluation of the esophagus.

Parental complaints of vomiting or regurgitation in neonates during the first 3 months of life are common. The cause is usually GER, particularly in the first weeks of life and with overfeeding. Neonates with normal weight gains tend to not have disease as the cause of their vomiting. GER may be diagnosed by medical history, watching an actual feeding, or monitoring esophageal acidity. Other than GER, common causes of vomiting in the first 6 weeks of life include neonatal sepsis, hypertrophic pyloric stenosis, and pylorospasm. It can occur with necrotizing enterocolitis in premature infants, often with the associated finding of bloody stools. Less common causes exist, with the most important one being the clinically emergent problem of bowel malrotation with midgut volvulus. Vomiting may also be present in cases of malrotation without volvulus, congenital atresia of the antropyloric area or small bowel or severe stenosis of small bowel (manifested in fetuses by polyhydramnios and dilated fluid-filled bowel), and functional obstructions caused by Hirschsprung's disease, small left colon syndrome, meconium ileus, or meconium plug syndrome. Causes that are even less common are neonatal appendicitis, intussusception, gastric ulcer disease, and lactobezoars. The less common causes outside the GI tract include intracerebral abnormalities

such as subdural collections, drugs or toxic agents, and medical conditions such as kernicterus, metabolic disorders, and renal problems.

Much of the differential diagnosis workup requires good clinical evaluation. Viral gastroenteritis often appears in epidemics, with sudden onset of vomiting, mild fever, and a relatively short duration. Systemic infections and metabolic disorders may be diagnosed by clinical and laboratory criteria. Hypertrophic pyloric stenosis may be diagnosed by feeling the classic olive of hypertrophied muscle. Intussusception, which is unusual in the first 3 months of life, may be diagnosed clinically by crampy abdominal pain associated with mildly bloody stools. Patients with increased intracranial pressure often have neurologic signs.

Once the child is 6 weeks of age, the clinician and radiologist must continue to be concerned about the aforementioned conditions, as well as formula intolerance and infectious causes such as urinary tract infection, pneumonia, otitis media, meningitis, and gastroenteritis. Less common causes include increased intracranial pressure from tumor or trauma, whooping cough, midgut volvulus, metabolic disorders (phenylketonuria, maple syrup urine disease, galactosemia, diabetes, adrenocortical hyperplasia, methylmalonic acidemia), and diencephalic syndrome.

When the clinical and laboratory assessment provides a definitive diagnosis and treatment plan, radiologic imaging is not required. Clinical diagnostic uncertainty requires use of imaging. The imaging workup of vomiting patients in the newborn to 3-month-old age group is discussed with regard to three different and not unusual clinical scenarios:

1. A newborn with bilious vomiting
2. A 4-week-old infant with intermittent nonbilious vomiting since birth
3. A previously normal 6-week-old infant with new-onset projectile vomiting

Scenario 1: Newborn with Bilious Vomiting

Regurgitation of the first few feedings of life is not uncommon. These infants must, however, be watched closely and examined frequently. The quality of regurgitated material gives clues as to location of possible obstruction. Bilious vomiting is usually due to sepsis or obstruction. It is a radiologic emergency because midgut volvulus about the superior mesenteric artery may lead to ischemia and necrosis of the small bowel distal to the point of volvulus. The requirement to treat bilious vomiting as an emergency is valid despite the fact that in one study of 45 patients with bilious vomiting in the first 72 hours of life (with 32 of them having bilious vomiting in the first 24 hours), only 20% had midgut volvulus, with 69% of cases having an idiopathic cause and a transient course and 11% having a lower gastrointestinal cause (meconium plug syndrome or left-sided microcolon). One must be wary to differentiate true bilious vomiting from inconsequential regurgitation of yellow colostrum or vomitus with meconium which is indicative of distal bowel obstruction.

Abdominal Plain Film

Abdominal plain film evaluation may show evidence of upper GI tract obstruction with dilatation of the stomach or small bowel to a point of obstruction. Plain films

that show bowel obstruction may obviate the need for further imaging. Negative plain films suggest the need for further evaluation. In one study, only 44% of patients who required surgery for bilious vomiting had a definitively positive plain film reading. The majority of patients (56% of the surgery group, and 30 of 31 idiopathic cases) showed normal or nonspecific plain films.

Contrast Upper Gastrointestinal Series

To answer the key imaging question in such patients - that is, whether the child has a mechanical obstruction - requires direct imaging of the stomach and small bowel. Many authors prefer the barium upper GI series. A few authors have discussed the use of low-osmolarity contrast agents for extremely ill or very premature infants or those with bilious vomiting. These contrast agents are used to evaluate the stomach, the egress of its contents through the pylorus and into the duodenum, and the course of the duodenum to the ligament of Treitz. Other authors have pointed out that US, with water used as a contrast agent, can be highly successful in imaging gastric emptying, GER, and duodenal abnormalities, including midgut volvulus. The major difficulty for some radiologists with regard to the use of US is that its success depends on the skill of the operator and that it is occasionally limited in following the entire course of the normal fluid-filled duodenum. Both the contrast UGI series and the fluid-aided US examination can reveal the dilated small bowel proximal to an atresia or stenosis and the beaked or twisted point of obstruction of the proximal small bowel in cases of midgut volvulus. The ability to follow a contrast column through the duodenum and note its route from right to left of midline and up to the height of the duodenal bulb to the area of the ligament of Treitz helps rule out bowel malrotation, whether the imaging is done with barium in an upper GI series or with water in US examination. One study, using US, noted the relationship of the superior mesenteric artery (SMA) to the superior mesenteric vein (SMV) in more than 200 children presenting with nonbilious vomiting. All five of five patients with the SMV to the left of the SMA had bowel malrotation, while one of four patients with the SMV anterior to the SMA had malrotation. The association of malrotation with midgut volvulus makes this finding of interest, but the key necessity is to rapidly assess when there is obstruction as the possible cause of bilious vomiting. A normal SMV/SMA relationship certainly does not preclude malrotation.

Individual cases of bilious vomiting associated with supradiaphragmatic herniation of the stomach or chronic gastric volvulus have been reported. Although plain film examinations may be diagnostically useful, as with other causes of bilious vomiting, contrast upper GI series or US are necessary to determine a point of obstruction.

Abnormalities of the lower GI tract that may be causes of bilious vomiting may be demonstrated by barium enema. The use of barium enema for the analysis of malrotation is less direct than analysis by UGI series.

Nuclear medicine studies, which can be highly effective in analyzing gastric emptying and GER, have no significant role in this diagnostic workup.

Scenario 2: Four-Week-Old Infant with Intermittent Vomiting Since Birth

There are several common causes of intermittent vomiting since birth. In a review of 145 such cases, 43 were due to idiopathic GER, 40 to hypertrophic pyloric stenosis, 27 due to overfeeding, 15 to pylorospasm, 14 to milk allergy, and one to gastroenteritis.

The most common cause for intermittent vomiting or regurgitation since birth is GER. Competence of the lower esophageal sphincter is based on anatomic and physiologic factors that are not perfectly understood. The sphincter mechanism is said to not be fully mature for at least the first 6 weeks of life, which would make reflux a very common finding, which it is. The topic of GER has engendered great debate among clinicians and imagers, and one researcher notes the continued questions over what a "positive" test is and how one defines "significant" reflux.

Other diagnostic possibilities include gastric ulcers, pylorospasm, and gastric volvulus.

The diagnostic workup for GER includes the current gold standard-the extended pH probe. The Tuttle test and esophageal motility studies are said to be unreliable in young children. Imaging studies are done to prove the refluxing of gastric contents into the esophagus. Depending on the clinical circumstances, the degree of reflux based on number of events over a given period of time, the height of the refluxing column, the quality of the esophageal mucosa, and evidence of aspiration into the lungs are important pieces of information. For the first analysis of a vomiting infant between 1 day and 3 months of age who does not have failure to thrive, many clinicians prefer to simply know whether GER or another phenomenon is the cause of clinical concern. Imaging evaluation can be made by a UGI series, which is said to be sensitive but less specific than the pH probe. The UGI series can analyze esophageal mucosal integrity, but fluoroscopic examination time is limited by concerns about radiation exposure. Reflux scintigraphy with 99m technetium (Tc 99m)-labeled sulfur colloid mixed in a feeding was noted by one research team to be 79% sensitive; that is slightly less sensitive than barium studies (86%) but much more specific (93% compared with 21%). Nuclear medicine scintigraphy can be used over a prolonged time without increasing radiation exposure and at a lesser radiation dose than the UGI series. However, the methodology and interpretation criteria are not uniform from center to center. This fact, and the lack of sensitivity of scintigraphy to aspiration, keep its use limited, by most authorities, to cases in which other modalities have excluded an anatomic cause for feeding disorders in children with a failure to thrive. Such patients are usually older than 3 months of age.

Ultrasound

US diagnosis of reflux is made by noting water placed into the stomach refluxing into the distal esophagus (after tube removal). Because US shows even more episodes of reflux than the UGI series, some consider it to be even less specific in diagnosing GER. On the other hand, one study, found US to be 100% sensitive and 87.5% specific in diagnosing GER. Another study found US successful in diagnosing 48 true positive and six true negative cases of GER with only one false negative. US can provide functional as well as morphologic information.

Plain Films

Although plain films do not play a role in the diagnosis of GER, mega-aeroesophagus seen as an air-filled esophagus at least 1 cm in diameter on the chest films of 16 chronic vomiters proved to be evidence of GER or esophageal obstruction.

UGI series, as well as US and scintigraphy, can show gastric emptying, which when delayed may indicate pylorospasm as a cause of persistent vomiting. US allows this to be accomplished without radiation exposure. Barium exams are certainly helpful in diagnosing hypertrophic pyloric stenosis (HPS), hiatal hernia, GER, and duodenal abnormalities. US allows evaluation of normal and abnormal pyloric lengths and muscle wall thicknesses. Information about imaging pylorospasm is scattered in the literature. One group suggests that it is common in infancy. They described antropyloric muscle wall thickness measurements to normally be 1 mm. Of the 17 cases they diagnosed as having pylorospasm, 15 had wall thickness measurements of >1 mm but <2 mm and two had pyloric muscle wall thicknesses as great as 2 to <3 mm. They warned that a contracted pyloric canal may appear falsely thickened if the US image is obtained in a tangential plane. In one study of 150 cases sent to sonography for possible HPS, seven cases were identified as "pylorospasm or evolving HPS." All had delayed gastric emptying as well as pyloric muscle wall thickening (1.3-2.7 mm) and pyloric canal elongation (lengths of 10-14 mm). All those measurements fall below those considered positive for diagnosing HPS. However, a more recent study indicated that the differentiation between HPS and pylorospasm may not be as simple. Of 31 patients diagnosed by US as having pylorospasm (and confirmed as such by clinical follow-up) six had pyloric lengths <18 mm, and 18 had muscle wall thicknesses >4 mm, measurements that simulate HPS, for at least a portion of their US study. Changeability of these measurements and evident gastric emptying of inserted fluid helped confirm the US diagnosis of pylorospasm. Pyloric muscle changeability and incomplete obstruction to fluid flow into duodenal bulb are US findings suggestive of pylorospasm and allowing differentiation from the unchanging thick wall of HPS.

Gastric ulcers have traditionally been diagnosed by the UGI series or endoscopy. One study used US to diagnose gastric ulcers in seven infants, six of whom had chronic vomiting and one of whom had syncope with "coffee ground" vomitus. US showed mucosal thickening of >4 mm, with a sharp demarcation between the normal and abnormal regions. Each patient had delayed gastric emptying, and findings could be confirmed by the UGI series.

Chronic gastric volvulus is not as uncommon as previously thought. In the neonatal and infant group, its primary presentation is recurrent vomiting. While plain films show no characteristic finding, the UGI series may show a high greater curvature, a greater curvature crossing the esophagus, a downward pointing pylorus, two airfluid levels, or a lowering of the gastric fundus, all of which are suggestive of gastric torsion. Gastric volvulus has a frequent association with GER. Sudden episodes of cyanosis and apnea, anorexia, or pneumonia in association with recurrent vomiting may indicate this entity.

In summary, most radiologists are comfortable with the UGI series for analyzing intermittent vomiting in the neonate or infant. There are proponents of US imaging for this analysis. Favored screening exams may be one or the other; some concern exists for US because of its operator-dependent accuracy.

Scenario 3: Previously Normal 6-Week-Old Infant with New-Onset Projectile Vomiting

The most common conditions producing acute vomiting at 6 weeks of age are GER, viral gastroenteritis, pylorospasm, and HPS.

HPS is typically suggested by projectile bile-free emesis in a previously healthy infant around 6 weeks of age. Projectile vomiting may be reported in patients with GER, particularly in overfed patients.

When a classic "olive" of hypertrophied pyloric muscle is palpated, the diagnosis of HPS can be made clinically, and the patient can be sent to surgery for a pyloromyotomy, without the need for imaging examinations. If no "olive" is palpated, imaging by plain film radiography, US, and/or an UGI series have been performed for diagnosis.

Plain Film

Plain film abdominal radiography may show gastric distension with HPS. On occasion, mass impression of the thickened pyloric muscle on an air-filled gastric antrum may be noted. However, radiographs are most often not helpful in HPS diagnosis and are usually nonspecific in cases of GER or gastroenteritis. One research team, in a retrospective review to determine the utility of plain abdominal radiography in children presenting to the emergency room, noted that of four children with HPS, none had plain films that were diagnostic. The films were suggestive of the diagnosis in only one case, while apparently normal in two of the cases, and misleading in the remaining single case.

Upper Gastrointestinal Series

The contrast UGI series is excellent for diagnosing obstructive causes of vomiting in this age group. In cases of HPS, one can note the mass impression of the hypertrophied pyloric muscle on the barium-filled antrum ("shoulder sign"), or the filling of the proximal pylorus ("beak sign") or the entire elongated pylorus ("string sign") with barium. The UGI series allow ready diagnosis of GER as well as less likely causes of obstruction such as midgut volvulus, gastric volvulus, or annular pancreas.

Ultrasonography

US has become a standard and highly accurate method for diagnosing HPS. It allows imaging of the pyloric muscle and channel, and the constant image of an elongated, thick-walled pylorus indicative of HPS. Measurements of pyloric channel length, pyloric diameter, and muscle thickness have been used by several authors for diagnosis. Overlap of these measurements between normal patients and those with HPS has been reported. This is particularly true regarding transverse pyloric diameter measurements, which are therefore considered less reliable. One study found muscle thickness the most discriminating and accurate measurement, noting it as 4.8 +/- 0.6 mm in HPS patients and 1.8 +/- 0.4 mm in normal patients. Measurements of 4 mm are considered positive for HPS, but measurements between 3 and 4 mm represent a gray zone, particularly in the

younger or smaller neonate. Muscle thickness measurement may be obtained on transverse or longitudinal views of the pylorus.

Another study considered a 2 cm pyloric length to be definitively abnormal in 33 of 33 HPS patients. Another research team felt that pyloric length was the only precise indicator of HPS. Their negative cases had no pylorus length longer than 14 mm. Their positive cases were all 18 mm or longer. An additional study reviewed several pitfalls of HPS diagnosis by US, including the creation of false thickening of the pyloric muscle wall by tangential views of the pylorus.

Just as with the UGI series, various ultrasonographic signs of HPS have been reported. Of note, however, is the fact that just as some reports have noted an overlapping of pylorospasm measurements with those of HPS during at least a portion of an US study, so too may some of the ultrasonographic signs thought specific for HPS be seen in cases of pylorospasm, for at least some portion of the study.

Changeability of pyloric length or muscle wall thickness measurements, or of the actual images of the pyloric area, from those consistent with the diagnosis of HPS to those that are normal or those that are not normal but not diagnostic of HPS, is suggestive of pylorospasm. This is particularly true if one can also note significant gastric emptying after the patient has been given a gastric fluid load (e.g. 60 cc or half a typical feed). Diagnostic caution with careful clinical follow-up has been suggested for the diagnosis of pylorospasm in neonates younger than 4 weeks of age or in premature infants who are the equivalent of less than 4 (full-term) weeks of age, to avoid the possibility of underdiagnosing cases evolving into HPS. Pylorospasm is said to be the most common cause of gastric outlet obstruction in this age group and unlike HPS, it is treated conservatively.

Sonography has the advantage over UGI series in that no ionizing radiation is used. It is the preferred method for diagnosing HPS. However, a negative US leading to a UGI series does not save the patient radiation exposure, and in fact it increases the expense of imaging. One study, in reviewing the cost, risk and benefit of first using US in the analysis of the vomiting child in two pediatric hospitals, found a 33% reduction in the number of UGI series performed, but a 95% increase in overall cost because the remaining patients went on to a UGI series. Another study found an increased cost among their patients because only 44% had HPS and the others went on to UGI series. The percentage of infants with projectile vomiting who have a US examination and then go on to UGI series varies greatly with the clinical and US practice of a given institution. This is particularly true with regard to whether (having ruled out HPS) GER or bowel rotation information obtained by US, as well as a trial of conservative treatment for possible or evident GER (via formula thickening and a more upright feeding position) are acceptable to the clinical staff before further pursuit of the diagnosis by radiological examination.

In addition, one must continue to bear in mind the necessity for continued vigilance in balancing the needs for an exact diagnosis with the need to limit radiation exposure, particularly when time of fluoroscopy is increased by evaluating gastric emptying times for cases of possible pylorospasm or by attempting to image reflux in cases of possible GER. As early as 1984, one study noted that prolonged observation of the passage of gastric contents may be

tedious but useful in helping to avoid surgery in cases simulating HPS. A more recent study reported on the helpfulness of repeated examinations - namely, using US, to analyze gastric emptying and changes in pyloric muscle thickening in successful attempts to treat HPS patients with titrated doses of atropine sulfate to avoid pyloromyotomy. Concerns for radiation exposure in children have been highlighted by recent works describing the adjustment of computed tomography (CT) exposure parameters in CT imaging of children. Again, experienced observers are necessary to avoid misdiagnosis and limit examination times.

Nuclear Scintigraphy

Nuclear scintigraphy has little place in the evaluation of the 6 week-old infant with projectile vomiting. If all other causes of vomiting have been excluded, it may be useful for functional evaluation of gastric emptying, although such patients are usually 3 months of age or older.

In summary, in imaging the 6-week-old infant with projectile vomiting, the choice between UGI series and US depends on careful clinical history and a likely primary diagnosis. If HPS or pylorospasm is likely and a pyloric mass is not palpated, sonography alone can be diagnostic. If other causes of vomiting, such as GER, are more likely, and a definitive diagnosis of them by imaging is considered necessary, performing a UGI series first can be more cost-effective.

Abbreviations

- GER, gastroesophageal reflux
- NUC, nuclear medicine
- UGI, upper gastrointestinal
- US, ultrasound

CLINICAL ALGORITHM(S)

Algorithms were not developed from criteria guidelines.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Selection of appropriate radiologic imaging procedures for evaluation of infants with vomiting

POTENTIAL HARMS

- The upper gastrointestinal (UGI) series can analyze esophageal mucosal integrity, but fluoroscopic examination time is limited by concerns about radiation exposure.
- Concerns for radiation exposure in children have been highlighted by recent works describing the adjustment of computed tomography (CT) exposure parameters in CT imaging of children.
- When using CT or ultrasound (US) experienced observers are necessary to avoid misdiagnosis.

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about [availability](#), see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Cohen HL, Strain JD, Fordham L, Gelfand MJ, Gunderman R, McAlister WH, Slovis TL, Smith WL, Expert Panel on Pediatric Imaging. Vomiting in infants up to 3 months of age. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 7 p. [39 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1995 (revised 2005)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Pediatric Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Panel Members: Harris L. Cohen, MD; John D. Strain, MD; Lynn Fordham, MD; Michael J. Gelfand, MD; Richard Gunderman, MD, PhD; William H. McAlister, MD; Thomas L. Slovis, MD; Wilbur L. Smith, MD

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Cohen HL, Babcock DS, Kushner DC, Gelfand MJ, Hernandez RJ, McAlister WH, Parker BR, Royal SA, Slovis TL, Smith WL, Strife JL, Strain JD, Kanda MB, Myer E, Decter RM, Moreland MS. Vomiting in infants up to 3 months of age. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun; 215(Suppl): 779-86.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the [American College of Radiology \(ACR\) Web site](#).

ACR Appropriateness Criteria® Anytime, Anywhere™ (PDA application). Available from the [ACR Web site](#).

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the [American College of Radiology \(ACR\) Web site](#).

PATIENT RESOURCES

None available

NGC STATUS

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